Replacement of a portion of a pole

The present invention relates to a method for replacing a least one portion of a pole with a new pole part. The invention further comprises a pole where at least one of the pole's original portions is replaced by a new pole part.

The invention will be suitable for all types of poles where one or more portions of the pole are damaged or destroyed, or where for other reasons it is desirable to replace one of the pole's portions.

This method will be particularly applicable to poles made of a wooden material, but it may also be applied to poles of another material such as plastic, concrete or a metallic material. With a method according to the invention, only the damaged portion/portions of the pole are replaced by a new pole part which is affixed to the remaining pole part or parts. By means of this method a pole is provided which comprises at least one remaining pole part and one new pole part.

The invention will be particularly suitable for poles where either the bottom, top or another portion of the pole is securely fastened or attached in a manner which entails the necessity of laborious operations in order to remove the pole to enable the whole pole to be replaced. Another motive for employing the invention may be that the pole is made of an expensive material, thus making it desirable to only replace the damaged portion of the pole instead of the whole pole. Furthermore, environmental considerations which make it desirable to reduce material consumption may also be an incentive for employing the invention.

For poles used for the suspension of cables, wires such as telephone wires, high-tension wires, etc., it is an arduous process to have to disconnect all the wires and equipment attached to the upper portion of the pole if the pole is damaged and has to be replaced. This type of pole is often buried in the ground or fastened to the ground at its lower portion. If the pole is made of wood it will usually be impregnated, for example with tar or resin. The pole will therefore be relatively resistant to wear above ground level. However, the lower end portion of the pole, i.e. the end of the pole located below ground level and immediately above ground level, will be more subject to damage due to rot, frost, geological faults and the like than the remaining portions of the pole. The poles may also risk snapping as a result of strong winds, and this damage will generally be inflicted on the poles at some distance above the ground.

According to current practice, the normal procedure is to replace the whole pole even though only one of the portions of the pole is damaged. This is an extremely labour-intensive operation due to the fact that the pole has to be released from the cables, the lower portion of the pole has to be released from the ground and the cables have to be held in position during the replacement operation. Thus there is a

need to provide a method where, when the pole is damaged, it is not necessary to replace the whole pole, but where any of the portions of the pole can be replaced without the whole pole having to be removed from the position in which it is located.

The problem of destruction of the lower part of a pole is well known in the field and there are also established techniques for undertaking the removal and replacement of the lower part of a pole.

In this connection we refer to publication US 4033080 in which a method is described for replacing the lower portion of a pole. The invention involves replacing the lower portion of the pole which is destroyed by a lower part made of concrete. The destroyed lower portion of the pole is severed from the rest of the pole by a horizontal cut which is oriented at right angles to the pole's longitudinal axis. The remaining part of the pole is attached to the new lower concrete part by means of an end holder which has a cavity in which the end of the remaining pole is placed and an opposite cavity where the end of the concrete part is engaged. The end holder is attached to the ends of the concrete part by bolts.

In NO 34507 a method is described for reinforcing a pole whose lower portion is damaged. According to this method a hole is dug round the pole's lower portion, whereupon reinforcing elements are attached to the pole some distance above the damaged portion. Concrete is filled in the hole round the lower portion, with the result that the lower ends of the reinforced elements are securely cast in the concrete. The pole's damaged portions are then sawn off and the lower part of the pole is completely cast in concrete.

In NO 38488 an improvement is described of the method in NO 34507 where the liquid concrete that is distributed round the hole round the pole's lower portion consists of ready-cast concrete elements with the reinforcing elements securely cast in the concrete.

Of the publications cited, US 4033080 discloses the most obvious technology. The invention differs from this prior art in several ways, as will be explained in the following.

The technique described in the above-mentioned publications relates to methods for replacing a lower portion of a pole which is damaged. The method according to the invention can be used to replace one or more portions of the pole, regardless of where along the length of the pole the damaged portion may be located. It is also possible according to the method to replace several portions in the same pole.

It is an object of the present invention to provide a method for replacing at least a portion of a pole. The method should be simple to implement and ensures that a

pole is obtained with optimum strength in the joint region, thus satisfying the prescribed requirements for poles. In this context strength refers to flexural strength, elasticity (modulus of elasticity), tensile and compressive strength. Poles which are provided by means of a method according to the invention are tested in accordance with regulations in order to reveal the effect of the joints on their strength. The flexural strength of the jointed poles is greater than the flexural stress permitted for wooden poles according to the regulations. It should also be mentioned that a pole which is jointed according to the invention has more flexible properties than the original pole. This means that when it is subjected to substantial loading the pole will not suddenly crack, but rather sustain a ductile fracture.

The method according to the invention involves firstly providing support for the pole so that it is held in a predetermined position when the cutting and replacement of the pole parts are to be carried out. The predetermined position will preferably be the original position in which the pole is located before the replacement of a portion of the pole is to be undertaken. It is therefore vital that the support device should be capable of providing sufficient holding force for the remaining part of the pole if, for example, the pole's lower portion has to be replaced. This applies particularly when the pole is employed for suspension of cables and wires. The pole may, for example, be supported by means of a support device such as a support tower or a crane truck with a gripping tool that grips the pole around its circumferential direction. Support wires may also be employed to provide the pole with additional support. A person skilled in the art will appreciate that the support for the pole may be provided in various ways depending on the location of the pole and which portion of the pole has to be secured.

When the support has been provided and the pole is held securely in the desired position, the pole is divided into at least two parts by a cut which is substantially diagonal. According to the invention the pole may be divided into more than two parts depending on which portions of the pole have to be replaced. The part or parts of the pole that have to be replaced are then removed.

The diagonal cut dividing the pole is performed in such a manner that the ratio (D:H) of the pole's diameter (D) to the height (H) of the cut is substantially kept within the range 1:15 – 1:5, preferably 1:12 – 1:7, most preferred 1:10. This ratio is produced by testing different diagonal cut ratios in order to work out which diagonal cut ratios provide the best basis for obtaining advantageous strength properties when the new pole part and the original pole part have to be joined.

The orientation of the cut is important for the strength of the joint. A diagonal cut which is positioned so that it approximates a substantially horizontal orientation is negative for the strength or stability of the pole. A diagonal cut which is positioned so that it approximates a vertical orientation is unsuitable in relation to length of

cut, time to make the cut, etc. With a diagonal cut with a steep gradient approximating a vertical position, several friction elements as well as several securing devices are required, which is both time-consuming and uneconomical.

After the damaged part has been removed, it is replaced by a new pole part which has at least one end portion with a diagonal cut face that matches the cut face of the remaining part or the remaining parts of the pole. When the pole part that has to be replaced is the pole's lower portion, the new pole part has to be buried in the ground or attached to the base in another way if the ground is so hard that digging is impossible. If it is one or more mid-sections of the pole that have to be removed, the new part is preferably placed in position by a suitable tool. If the pole's upper portion has to be replaced, this is a more laborious operation, since wires and wire equipment have to be released from the pole and the new top part has to be placed in position before being attached to the original pole part.

When the new pole part has been manoeuvred into position, the new and the original pole parts are joined. The pole parts are joined by placing attachment devices, each extending around the circumference of the pole, in the joint region, with the result that the attachment devices encircle both the original and the new pole parts. The attachment devices are distributed at intervals in the pole's longitudinal direction in the joint region to ensure that the diagonal cut faces of the new pole part and the remaining pole part(s) are held close together.

Each of the attachment devices employed may be a band-shaped clamping ring which is attached around the joint region after the pole parts have been joined. Alternatively, the clamping ring is placed around the new or the original pole part and then moved into position in the joint region after the pole parts have been joined.

So-called hose clamps equipped with teeth around their circumference and facing inwards in engagement with the pole may also be used as an alternative attachment device.

In order to improve the pole's strength, additional use may be made of at least one friction element, which is placed between the cut faces of the pole parts in the pole joint and prevents sliding between the pole parts. The friction element employed may be composed of a continuous element adapted to the area or possibly the length of the diagonal cuts. Alternatively, several friction elements placed side by side between the cut faces may be employed, the number of friction elements being determined by the individual friction element's size and the length of the diagonal cuts. The friction element may be in the form of a strip, in the form of a piece of cloth or a more rigid body. In an embodiment of the invention friction elements are employed with double-acting barbs such as timber connectors of the "bulldog plate" type, with, for example, dimensions from 100 mm x 100 mm to 130 mm x 130 mm.

In a preferred embodiment of the invention four bulldog plates (130 mm x 130 mm) will be placed between the joint faces. Each of the bulldog plates may be placed under each of the four middle clamping rings. Alternatively, more than four, e.g. seven bulldog plates may be placed in the joint.

In an alternative embodiment of the invention an adhesive may be applied to at least one of the pole parts' end portions in the pole joint. The adhesive may be employed as a replacement for the friction elements or as a supplement thereto. The adhesive may be a conventional type such as glue, a tar-based agent, etc.

Instead of using friction elements, the diagonal cut may be provided with a gradation which may take different forms at its termination against the surface of the pole. By means of this gradation a stiffening of the pole is achieved. In addition or alternatively, a sleeve may be employed under the attachment devices, the sleeve being instrumental in holding the pole parts together, thus avoiding sliding.

In order to ensure that the characteristic flexural strength is greater than the permitted flexural stress, the results of the testing of the poles show that use may be made of six clamping rings and four friction elements of the bulldog plate type with dimensions 130 mm x 130 mm. The testing further shows that it is advantageous to employ more than four bulldog plates between the joint faces in order to achieve a satisfactory design flexural strength. To achieve the optimal result, it will be desirable for the friction element or friction elements to represent an area corre-sponding as closely as possible to the size of the pole parts' cut face.

When the pole is divided by a diagonal cut, a reduced diameter is obtained at the joint region's upper and lower portions. The reduction in diameter results in a reduction in the flexural strength. In order to improve the pole's flexural strength, according to an embodiment of the invention a reinforcement may be employed in the form of a tension body which is attached to two of the attachment devices. The object of the tension body is to absorb the tensile forces in cases of extreme bending of the pole. In a preferred embodiment one end of a tension body may be attached to the two uppermost attachment devices and the other end to a portion of the upper pole part located outside the joint region. Furthermore, one end of a second tension body is attached to the two lowest attachment devices and the other end of the tension body to a portion of the lower pole located outside the joint region.

According to the invention a pole is provided where at least one of the pole's original portions is replaced by a new pole part. The pole thereby comprises at least one remaining pole part and at least one new pole part. At least one of the end portions of the new pole part is in the form of a diagonal cut which is adapted to fit the diagonal cut of the remaining pole part(s), with the result that the remaining pole part or parts and the new pole part match in the joint region. Several attach-ment devices are provided, each extending around the circumference of the pole in

the joint region, with the result that the attachment devices encircle both the original pole part and the new pole part. The attachment devices are arranged at intervals in the pole's longitudinal direction in the joint region in order to ensure that the diagonal cut faces of the new pole part and remaining pole part(s) are held together.

The new pole part will preferably be of the same material as the older pole part, but may also be of another material, the crucial feature of the invention being the manner in which the original and the new parts are joined.

In a preferred embodiment of the invention the attachment device connecting the new and the original pole parts is a band-shaped clamping ring. The clamping ring preferably has an adjustable diameter and is equipped with devices for securing the clamping ring's chosen diameter.

In yet another preferred embodiment of the invention the clamping ring comprises a first elongated clamping ring body which is substantially circular in shape. The first end of this first clamping ring body is provided in slidable abutment with the inside of the second end of the first clamping ring body. On the outside of the second end of the first clamping ring body there is arranged a projection with at least one through-going aperture. A plurality of through-going apertures are provided near the first end of the first clamping ring body, the through-going apertures being arranged at intervals along the circumference of the first clamping ring body. A second clamping ring body has an elongated part provided with one or more through-going apertures along the circumference of the second clamping ring body and on its outside it is provided with a projection with at least one through-going aperture.

The diameter of the clamping ring is adjustable since the second clamping ring body can be moved between different positions along the first clamping ring body and can be attached to the first clamping ring body in these different positions. The attachment can be implemented by an optional number of attachment bodies being passed through the through-going apertures (one attachment body in each aperture) in the second clamping ring body and in the first clamping ring body and secured in this position. A second attachment body, for example a bolt with nut, is engaged in the through-going apertures of the two projections of the first and the second clamping ring body respectively, and can thereby be employed for tightening the clamping ring.

Normally 5-7 clamping rings will be used, with 6 clamping rings per joint being most preferred. The determination of the number of clamping rings will depend amongst other things on the length of the diagonal cut, and it is left to the skilled person to decide how many clamping rings will be sufficient in each individual case.

Even though a clamping ring designed as described above is particularly suited for providing holding force between the original and the new pole part, other attachment devices will also be suitable for use on the pole. As a person skilled in the art will understand, the crucial feature is that the individual attachment device fulfils the conditions that must be met by the attachment device in the independent patent claims. The special design and detailed mode of operation are therefore of secondary importance in this connection.

According to an embodiment of the invention at least one friction element is provided between the pole parts' cut faces in the pole joint. The number and size of friction elements may vary. The friction element is preferably provided with barbs on one or both sides of the friction element. The friction element may, for example, be composed of sun rings, strips or flat metal squares of the bulldog plate type. See also the section on the friction element under the method for mounting the friction element in the joint. An adhesive may be applied to at least one or both end portions of the pole parts in the pole joint in order to further reduce the possibility of sliding between the diagonal cut faces in the joint.

In order to improve the strength of the pole, one or more tension bodies may be attached to two of the attachment devices. It will preferably be appropriate to employ two tension bodies where one tension body is attached to the two uppermost attachment devices and the other to the two lowest attachment devices. The individual tension body is preferably elongated and oriented in the pole's longitudinal direction, with the result that a portion of the tension body extends outside the pole's joint region and can be attached to the upper and lower parts of the pole respectively.

An example of an embodiment of the invention will now be described with reference to the figures, in which;

Fig. 1 illustrates equipment employed for removing a lower portion of the pole.
Fig. 2 illustrates tools employed for executing the cut.
Figs. 3-5 are a detailed view of the cut that is made.
Figs. 6-7 illustrate two alternative embodiments of the attachment device.
Fig. 8 illustrates an embodiment of a friction element according to the invention.
Figs. 9-10 illustrate a tension body for reinforcement of the joint.

The embodiment described below relates to replacement of the lower portion of a pole. This is intended only as an illustrative example since the invention is suitable for replacement of any of the portions of a pole.

Figure 1 illustrates a crane truck equipped with a gripping tool 5. The gripping tool 5 is used to support a pole 1. It can be seen in figure 1 that the pole 1 is divided into two parts 2, 3 by a diagonal cut. The lower pole part 3 is shown buried in the

ground. The crane truck with the gripping tool 5 ensure that the pole part 2 is held in a stable position both when the actual cutting operation is performed on the pole and after the pole 1 is divided in two and the upper part 2 is released from the lower part 3. The pole 1 illustrated in figure 1 is used for suspending wires and it is therefore important to hold the pole part 2 in the position it had before the cut was made.

Support devices other than a crane truck with gripping tool may be employed for this operation, a prerequisite for the support device being that it is capable of providing sufficient strength and stability to enable the remaining part of the pole to still be held in a stable position when the damaged pole part is removed. This applies regardless of which pole portion has to be removed.

Figure 1 also illustrates a digger employed to dig round the lower pole part 3 in order to remove the lower pole part 3 and to bury a new pole part in the ground.

Figure 2 illustrates a tool 17 employed to perform the diagonal cut dividing the pole into two parts. This tool may be a conventional cutting tool such as a pole cleaver, a power saw, a manual saw, etc.

In figures 3 and 4 a pole according to the invention is illustrated where the lower pole part 3 is replaced by a new lower pole part 3' which is buried in the ground. The end portion of the new pole part 3' has a shape or diagonal cut form which is matched to the remaining pole part 2 so that they together form a pole 1.

Attachment devices 7 are mounted around the circumference of the pole in the joint region in such a manner that they encircle both the original pole part 2 and the new pole part 3'. In the joint region, the attachment devices are distributed at intervals in the pole's longitudinal direction, ensuring that the diagonal cut faces of the new pole part 3' and remaining pole part(s) 2 are held together in the joint region. Six attachment devices are used on the pole 1 in figure 1, but this number may be varied depending on the length of the diagonal cuts 4.

The diagonal cuts of the remaining and new pole parts 2, 3' are illustrated here by 4. The cut will preferably be made at a certain height above ground level, thus giving easy access to the cut face. In an embodiment of the invention the cut will start approximately 0.5 m above the ground and extend over an axial distance along the pole of around 2.5 m. The pole diameter will be around 15-25 cm, for example 18 cm at the top of the pole. The top of the pole is normally slightly tapered.

It has been found that the ratio D:H of the pole's diameter D (or diagonal if the pole is square) as illustrated in figure 5 to the cut's height H as illustrated in figure 5 should be within the range 1:15 – 1:5, preferably 1:12 –1:7, most preferred 1:10.

The preferred angle of the cut will consequently be 84.3°, which is the angle between the pole's diameter and the diagonal cut as illustrated in figure 5.

Various types of attachment devices may be employed in the joint region for holding the original 2 and the new pole part 3' together. The attachment devices may be mounted around the pole parts before or after their cut faces have been joined.

In figure 6 there is illustrated an embodiment of such an attachment device in the form of a clamping ring 7'. The clamping ring 7' is provided with a bolt and nut which are employed for adjusting the clamping force that has to be exerted by the clamping ring 7' on the pole parts. The capacity of the clamping ring 7' to adapt to poles of different diameters is limited. In an embodiment, the clamping rings may, for example, have rings which are 4 mm or 5 mm thick.

Figure 7 illustrates a clamping ring 7 which is provided so as to be capable of being adapted to poles of different diameter. The clamping ring 7 comprises a first elongated clamping ring body 8 which is circular in shape. One end of the clamping ring body 8 is moved in slidable abutment on the inside of the second end of the clamping ring body 8. As illustrated in figure 7, the outside of this second end is designed with a projection 9 which is provided with at least one through-going aperture 9'. The projection 9 may either be designed as a part of the clamping ring body 8 or it may be designed as a separate part affixed to the clamping ring body 8. Furthermore, the clamping ring body 8 is provided with through-going apertures 10 arranged at intervals along the circumference of the first clamping ring body 8 near the first end. The number of apertures 10 and the size of the space between them may be varied depending on how diametrically tolerant the clamping ring 7 requires to be. The term diametrically tolerant refers here to how much difference there is between the largest and smallest diameter the clamping ring has to fit.

The clamping ring 7 is further equipped with a second clamping ring body 11 which has an elongated part provided with a plurality of through-going apertures 11'. The second clamping ring body is provided with a projection 12 with at least one through-going aperture 12'.

The diameter of the clamping ring 7 can be adjusted by the second clamping ring body 11 being moved between different positions along the first clamping ring body 8 and attached to the first clamping ring body in the desired position. The attachment is implemented by one or more attachment bodies 13 being passed through through-going aperture 11' and through-going aperture 10 and secured in this position.

In order to tighten the clamping ring 7 around the pole concerned, a second attachment body 14, e.g. a bolt 14' with nut 14'', which is located in the through-going apertures 9', 12', is tightened.

At least two such clamping rings will be employed to hold the original and the new pole parts together. The number of clamping rings may be varied, but up to six will be preferred. It is also possible to employ attachment devices of different kinds on the same pole. For example, the clamping ring illustrated in figure 6 and the clamping ring illustrated in figure 7 may be combined in the same joint.

Figure 8 illustrates an example of a friction element in the form of a bulldog plate 15.

In figures 9 and 10 two tension bodies 16 are illustrated. The tension bodies 16 are in the form of an elongated, flat body. One tension body is attached to the two upper attachment devices at one end, while the other end protrudes outside the joint region and is attached to the upper pole part. The second tension body is attached to the two lower attachment devices at one end, while the other end of the tension body protrudes outside the joint region and is attached to the lower pole part. The attachment of the tension bodies 16 illustrated here is implemented by means of screws and nuts, for example French wooden screws.

In figure 11 an alternative embodiment of the pole's cut is illustrated, where the diagonal cut is provided with gradations at the termination against the surface of the pole.